INTERNATIONAL

TSUNAMI

INFORMATION

CENTER

NEWSLETTER

Volume VII, Number 2
August 1974

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NEW DIRECTOR FOR ITIC

A new director has been appointed to serve as Director of the International Tsunami Information Center in Honolulu. He will assume his new post about October 1, 1974, succeeding Mr. R. A. Eppley, who has been chosen as Chief of the Palmer Observatory, Palmer, Alaska. In addition to his ITIC duties, the new director serves as the State of Hawaii Tsunami Advisor. The operational aspects of the tsunami warning system have not changed except for continual efforts to improve the warning system.

UNESCO INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION FOR THE TSUNAMI WARNING SYSTEM IN THE PACIFIC

The fourth session of the Executive Council met in Ottawa, Canada, June 17-22, 1974. The Executive Council,

Having reviewed the report and recommendations of the fourth session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU) (doc. IOC/ITSU-IV/3);

Noting that the International Co-ordination Group prepared a statement of functions of the International Tsunami Information Center (ITIC) (Annex to recommendation 1), and recommended that an Associate Director be appointed for the ITIC (recommendation 2) and that standard international wave reporting procedures for tide observers be adopted (recommendation 3);

Desiring to continue its support for the expansion and improvement in the Tsunami Warning System (TWS) and the operation of the ITIC, particularly for its role in assisting developing countries wishing to take part in and benefit from the TWS;

Invites Member States to continue to use existing radio and other telecommunications including high frequency radio in the Tsunami Warning System;

Recognizing that the ITIC and the International Council of Scientific Unions' (ICSU) World Data Centres (Tsunami) provide complementary tsunami information and data services;

Requests the Director of ITIC to inform ICSU of the data archival and exchange requirements of the TWS as expressed by the International Co-ordination Group;

Requests ICSU to revise its procedures for archival and exchange of tsunami-related data as suggested by the International Co-ordination Group;

Approves the Summary Report of the above session (doc. IOC/ITSU-IV/3) and the recommendations contained therein with the exception of the statement of functions of the ITIC (annex to rec. ITSU-LV/1);

Supports fully the expression of appreciation (contained in Recommendation ITSU-IV/1) to the Government of the USA for the continued support provided to the ITIC;

Endorses the designation of an Associate Director of the ITIC;

Instructs the Secretary to invite Member States of the ICG/ITSU to nominate candidates to him for the Associate Directorship of the ITIC;

Requests the selection, with the assistance of the Chairman of ITSU and the Secretary, an Associate Director for ITIC;

Instructs the Secretary to arrange for a fifth session of the ICG for ITSU to be held in a Latin American Member State.

Annex to Recommendation I - ITIC Functions:

To give technical advice on the equipment required for an effective warning system and to provide assistance in the establishment of national warning systems.

Periodic study and assessment visits should be made to developing countries in order to evaluate their instrumentation requirements, assess their performance, offer advice as appropriate, and suggest avenues for assistance.

To evaluate the performance of the Tsunami Warning System with regard to communications, data networks and the dissemination of warnings.

To continue to coordinate the development of the observing system which will provide the information necessary for the issuance of effective tsunami warning to those nations wishing to receive such messages.

To maintain a full file of data related to tsunamis as obtained from the WDC's and from the real-time Tsunami Warning System, to serve as part of the basis for the information services, materials for visiting scientists and data compilations and summaries described below. ITIC should maintain close contact with IUGG (International Union of Geodesy and Geophysics) regarding updating of the ICSU Guide to International Data Exchange to meet changing needs of research and in light of new developments in observational techniques as seen at ITIC.

To encourage a visiting scientist programme by providing facilities at ITIC and arranging for exchange of scientists among countries.

To publish a Newsletter on a regular basis and distribute it to interested individuals and institutions.

To publish and disseminate appropriate compilations of tsunami information and data. Such publications may include regional tsunami catalogues and yearly summaries of tsunamis.

To maintain a library of publications related to tsunamis.

TSUNAMI RESEARCH SUMMARY CONDUCTED FOR THE COASTAL ENGINEERING RESEARCH CENTER

From August 1966 to August 1973, the U.S. Army, Coastal Engineering Research Center funded tsunami related research which was conducted by the Hydraulic Engineering Laboratory of the University of California.

The research concentrated primarily on laboratory experiments utilizing the Hydraulic Engineering Laboratory facilities of the University of California. The resulting work can be divided into the following classes of studies: (1) Wave generation by rockfall into a reservoir (non tsunami), (2) generation of waves by moving boundaries, (3) statistical properties and prediction of joint tide and tsunami occurrence, (4) non-linear properties of tide gages and the effects of this on tsunami measurement, and (5) analysis of non-stationary time series, with special application to tsunamis. Mr. George Pararas-Carayannis of Coastal Engineering Research Center, has provided us with the following summaries of this research.

1. "Long Wave Profiles over a Slope," by Ralph H. Cross and R. L. Wiegel,

Technical Report HEL 16-1, October 1966, 17 pages.

This study provides a numerical method by which long period wave length over bottoms of constant slope can be calculated. Such information is of definite value in studies of runup and in the design of coastal protective structures from tsunamis or other long period waves, and in studies of resonance effects within bays and harbors. It should be pointed out, however, that the profiles given by this study represent a rough approximation as, in nature, the slopes are composite and a large part of the long wave energy of the tsunami frequency is reflected at the continental slope. Furthermore, the linear shallow water theory may be an oversimplification when applied to the whole spectrum of tsunami waves. Although true for the initial tsunami wave which travels at a speed $C = \sqrt{gd}$ the profiles of subsequent waves would be difficult to obtain as there would be unforeseen interactions for which the model does not provide. Therefore, the validity of this model for resonance studies of a certain bay, for example, may be limited. The study may be more valid for waves of shorter period, than it is for the initial wave of a tsunami period (15 minutes or more).

2. "Non-linear Wave Effects on Tide Gages," by Ralph H. Cross, Technical

Report HEL 16-2, May 1967, 29 pages.

Waves of intermediate periods are damped when recorded by ordinary tide gages, while tidal or other long term fluctuations are accurately followed. This study provided a numerical method to correct for non-linear wave effects recorded by tide gages of long period fluctuations of water level. It is, therefore, a method to indicate the occurrence and approximate magnitude of the errors in tide gage records, and it is concerned primarily with waves of lesser than tsunami frequency for which underestimates

would be plotted on the tide gage record. This research could be useful in deciding the type and desirable characteristics of tide gages for a variety of water depths, wave heights, wave periods, and coastal sites. It may be of limited importance to the initial waves of the tsunami frequency, which appear to be recorded accurately by tide gages. Waves at a later phase of a tsunami, however, are of higher frequency and may be damped by the gage. The study provides corrections for such waves.

3. "Methods for the Analysis of Non-Stationary Time Series with Application to Oceanography" by Lloyd John Brown, Technical Report HEL 16-3, May 1967, 135 pages.

This study deals primarily with theoretical studies of the analysis of tsunami marigrams and other nonstationary time series. Specifically the study provides, through a statistical approach, a means of estimating the time-varying, spectral density of a tsunami. This is a highly mathematical treatise of the subject. It creates a nonstationary mathematical model of the sea surface. It regards the water surface as the probabilistic limit of sums of waves from different frequency bands. Although individual components may be harmonic, resulting water surface oscillations are nonharmonic. The model treats statistically probabilistic distribution of superpositions, the randomness of the process, and other second order stochastic evolutionary processes. The usefulness of these methods would be in the analysis of tsunami marigrams to see the power spectra of the tsunami waves, specifically how the wave energy builds up, peaks and decays at a particular station. Conceivably, such spectral analyses could be used to study resonance effects of a tsunami in a basin, or to distinguish from an irregular marigram the allocation of power and the frequency of peak energy.

In applying it to the Crescent City marigram record from the Alaskan tsunami of 27 March 1964, the study shows wave energy concentration about 13 hours after the arrival of tsunami. The slow rate of decay following the peak is indicative of resonance activity and response of this site. Applicability of this method would be particularly good for studying the tsunami response of basins or quasi-basins.

4. "Frequency Response of Tide Gages," by Ralph H. Cross, Technical Report HEL 16-4, August 1967, 13 pages.

This is continuation of work given in Report No. 2. The results of this study lead to the conclusion that tide gages respond well to tsunami oscillations if the periods are longer than 5 minutes for tsunamis 2 feet high, or 15 minutes for tsunamis 20 feet high. The study furthermore provides graphs which permit correction for the heights and the time lag of the peak.

Although the conclusions of this work indicate that most of the records of tsunamis obtained by tide gages are good representations of most tsunami

water fluctuations, it is also implied that certain water oscillations of lesser or greater period and amplitude would be distorted. Therefore, records of the smaller, or the later phases of large tsunamis, which include oscillations of greater frequency, would be subject to greater distortion. If one were to use the tsunami marigram to study effects of resonance in a bay, his basic data could be inaccurate. Similarly, it is important that spectral analysis should take distortion into consideration.

5. "Theory of Water Waves Generated by Time-Dependent Boundary Displacement," by Edward Noda, Technical Report HEL 16-5, October 1969, 225 pages.

This study addresses the problem of water wave generation from vertical and horizontal boundary displacements simulating landslides. Analytical solutions are obtained for two- and three-dimensional, time-dependent, boundary-motion problems, and are compared to experimental data obtained from physical models. For the water wave generation a two-dimensional solution is applied using the linear theory of gravity surface waves. Landslides are principally regarded by the theoretical solutions as time-dependent, horizontal-velocity, boundary displacements. This is an assumption which bears little resemblance to the actual natural phenomenon of wave generation by landslides in closed estuaries, and to tsunami generation in the open sea. A limitation of this study is that solutions are obtained for simplified analytical cases. Verification with the physical model may be somewhat unrealistic. In nature, landslides occur randomly, have assymetrical dimensions, and involve complex boundary movements. The study is, however, a good theoretical treatise of the subject, but may be of limited practical application to engineering design of structures in estuaries, reservoirs, or in the ocean.

6. "Empirical Probability Distribution for Astronomical Water Heights," by R. D. Borcherdt and L. E. Borgman, Technical Report HEL 16-6, July 1970, 34 pages.

Tsunamis occur randomly in time and could arrive at a coastline at any phase of the astronomical tide. The astronomical tides, however, are predictable events, and the probability distribution of astronomical water height can be determined.

This study developed a numerical method for estimating the empirical probability distributions of astronomical water heights as predicted from the tidal constituents derived by the National Ocean Survey. This is information of considerable significance in estimating the cumulative probability distribution of the combined tsunami and astronomical tide water heights at a point on the coast. For example, such cumulative probability distribution could be used by federal agencies in designating potential coastal flood zones, based on event frequency, or frequency of exceedance of a certain water height. Similarly, this information is significant to the design of coastal engineering works, offering protection not only from tsunamis, but

from hurricane surges or storm waves, where cumulative superposition and frequency of occurrence are used as criteria for the design.

7. "Water Waves Generated by Horizontal Motion of a Vertical Wall," by M. M. Das and R. L. Wiegel, Technical Report HEL 16-7, February 1971, 59 pages.

This is an experimental comparison of the numerical solutions obtained by Noda (Report No. 5) on the characteristics of surface waves generated by the time dependent horizontal motion of a vertical wall. These flume experiments are in reasonable agreement with the linearized solutions obtained by Noda. The study, however, may be of limited application to the problem of tsunami generation, as horizontal tectonic displacements are not known to produce significant tsunamis. Similarly, landslides generate waves by water volume displacement. The horizontal component of motion associated with landslides is not very significant except perhaps in closed estuaries, and a great deal of energy imparted to the water by landslides is in the form of turbulence.

8. "Frequencies of Crest Heights for Random Combinations of Astronomical Tides and Tsunamis Recorded at Crescent City, California," by Charles Petrauskas and L. E. Borgman, Technical Report HEL 16-8, March 1971, 64 pages.

This study develops a computer program to evaluate the effect of the time of occurrence of tsunami on the maximum water level elevation associated with the tsunami, considering superimpositional fluctuation of the astronomical tide. The end result is a frequency histogram for the fraction of the year the astronomical tides would combine with a given tsunami to produce a specified water level elevation.

This is a statistical method of studying effects of superimposition of past recorded tsunamis and the astronomical tide at a given coastal site. It is of limited applicability to the prediction of future effects of such superimposition, as tsunami crest arrival is a unique phenomenon occurring randomly in time, while the tide is a harmonic water level motion of cyclical periodicity. The study could be useful to the design of coastal protective works at a given coastal site provided there was sufficient historical tsunami data and astronomical tide information to establish a statistical relationship between the two. Conservative design practice would require combining the tsunami with a high tide to obtain a design water level.

9. "A Study of Water Waves Generated by Tectonic Displacements," by William J. Garcia, Jr., Technical Report HEL 16-9, May 1972, 114 pages.

This is a study of water wave generation using physical and numerical models. Primarily this research provides information on the leading wave

in the vicinity of an "alleged" impulsive tectonic source. In the laboratory study, waves were generated by the horizontal impulsive motion of a vertical wall, a 1:1 slope wall, a 1:2 slope wall and an underwater step. The numerical study used the Eulerian incompressible hydrodynamic method to generate waves from a hypothetical ocean-floor displacement associated with an assumed major earthquake, on the eastern section of the Mendocino Escarpment. The study provided information on behavior of the waves over the first 200 seconds of their generation.

Tsunami generation is a very complex phenomenon and is difficult to simulate with a physical, three-dimensional model, due to the problem associated with scale effects. It is even more difficult to simulate tsunami generation in a wave flume and treat it as a quasi, two-dimensional phenomenon, as a flume does not permit for lateral dispersion. The initial character of the waves is altered by the two-dimensional channel of the flume. The slopes of wall motion which were used with the flume experiments of this study, therefore, are not truly representative of tsunamigenic tectonic motions. Tectonic motions responsible for tsunami generation in nature involve primarily vertical ocean-floor displacements.

Limitations of the numerical method are the assumptions of the source mechanism used for the generation of the waves. The Mendocino Escarpment is not a representative tectonic source for tsunami generation. The assumed ocean floor displacements are two-dimensional, and in the horizontal plane. The study, however, generates useful information on the initial character of the waves associated with this mode of generation and provides data on leading-wave characteristics.

10. "Three-Dimensional Hydraulic Model Study of Water Waves Generated by Tectonic Displacements," by Shin-Lin Liu and R. L. Wiegel (in press).

This is a laboratory investigation of simulated tectonic displacements using a three-dimensional hydraulic model. It is an extension of the study by Garcia (Report No. 9) which was based on two-dimensional laboratory and numerical models. Because of the hydraulic model's size, and the plunger shape and dimensions, the model used in the study is not truly three-dimensional. As in the Garcia study, only wave generation from horizontal motions of submerged plungers were investigated. Such motions are not representative of the important tectonic motions responsible for tsunami generation. However; the study generates valid information on the characteristics of waves generated by such modes of generation.

TSUNAMI INVESTIGATIONS -- April-July 1974

The Tsunami Warning System at the Honolulu Observatory investigated several possible tsunamigenic earthquakes which are listed below. No Pacific-wide tsunami had been generated. Not included in this list are several that were of lower magnitude or that had occurred considerably inland.

Date and Origin Time (U.T.)	Epicenter	Depth	Magnitude	Region	Comments
June 4 04-14-15.9	15.8S 175.1W	276	6.7	Tonga Islands	No evidence of tsunami
July 2 23-26-33.1	27.8S 175.7W	Normal	7.3	Kermadec Islands	No evidence of tsunami
July 13 01-18-25.0	8.0N 77.0W	Normal	7.3	Columbia-Panama border	No evidence of tsunami

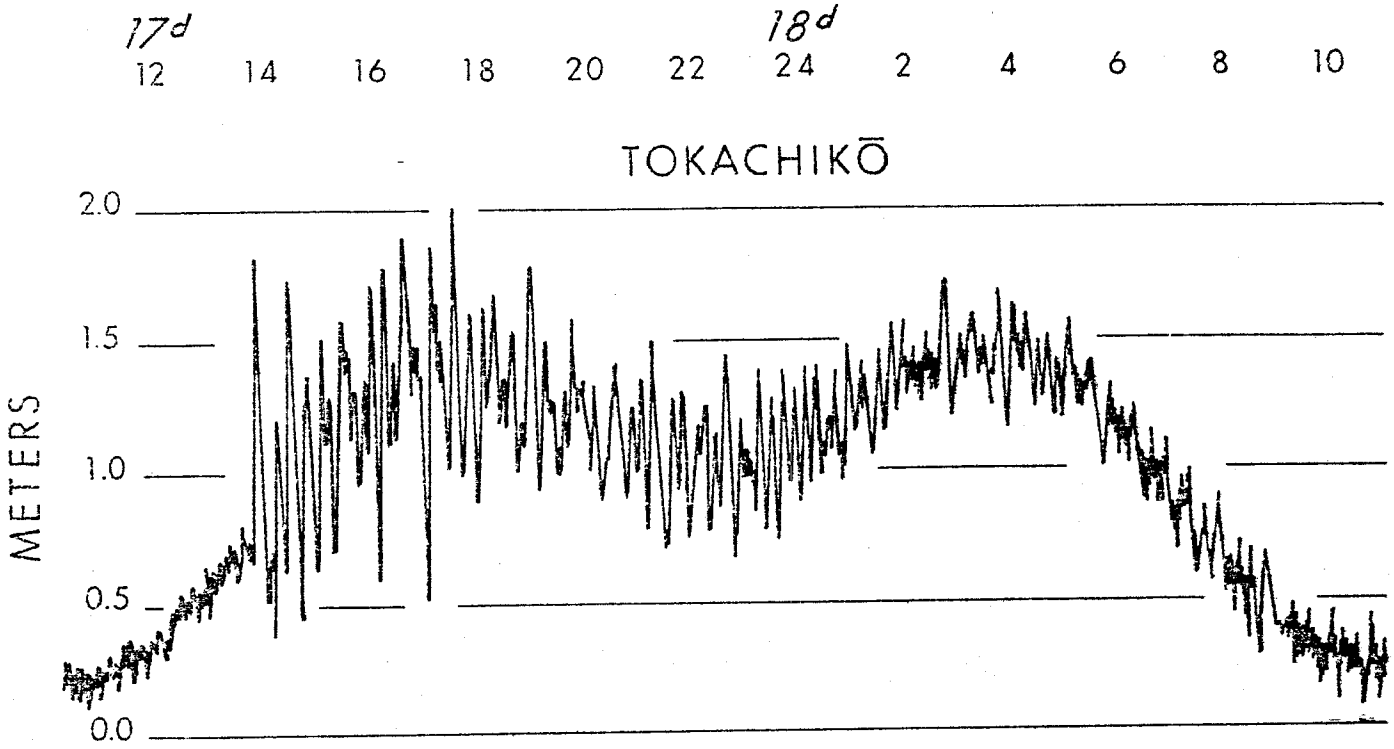
A small local tsunami resulted from the 17 June 1973 earthquake at Hokkaido, Japan. Copies of the first part of two of the wave records are shown.

REQUEST FOR DIGITIZED TSUNAMI RECORDS

No new digitized tsunami records have been received to add to our collections listed in the Vol. 7, No. 1, ITIC Newsletter. Please send either cards or listings including data sets for background tsunami frequency wave studies.

TSUNAMI WORKSHOP

There is to be a Tsunami Workshop at the University of California conference facility at Lake Arrowhead, California, October 13, 14, 15, and 16. Sponsorship is by the NSF and NOAA and invited participants will be presenting informal papers related to a wide variety of tsunami problems.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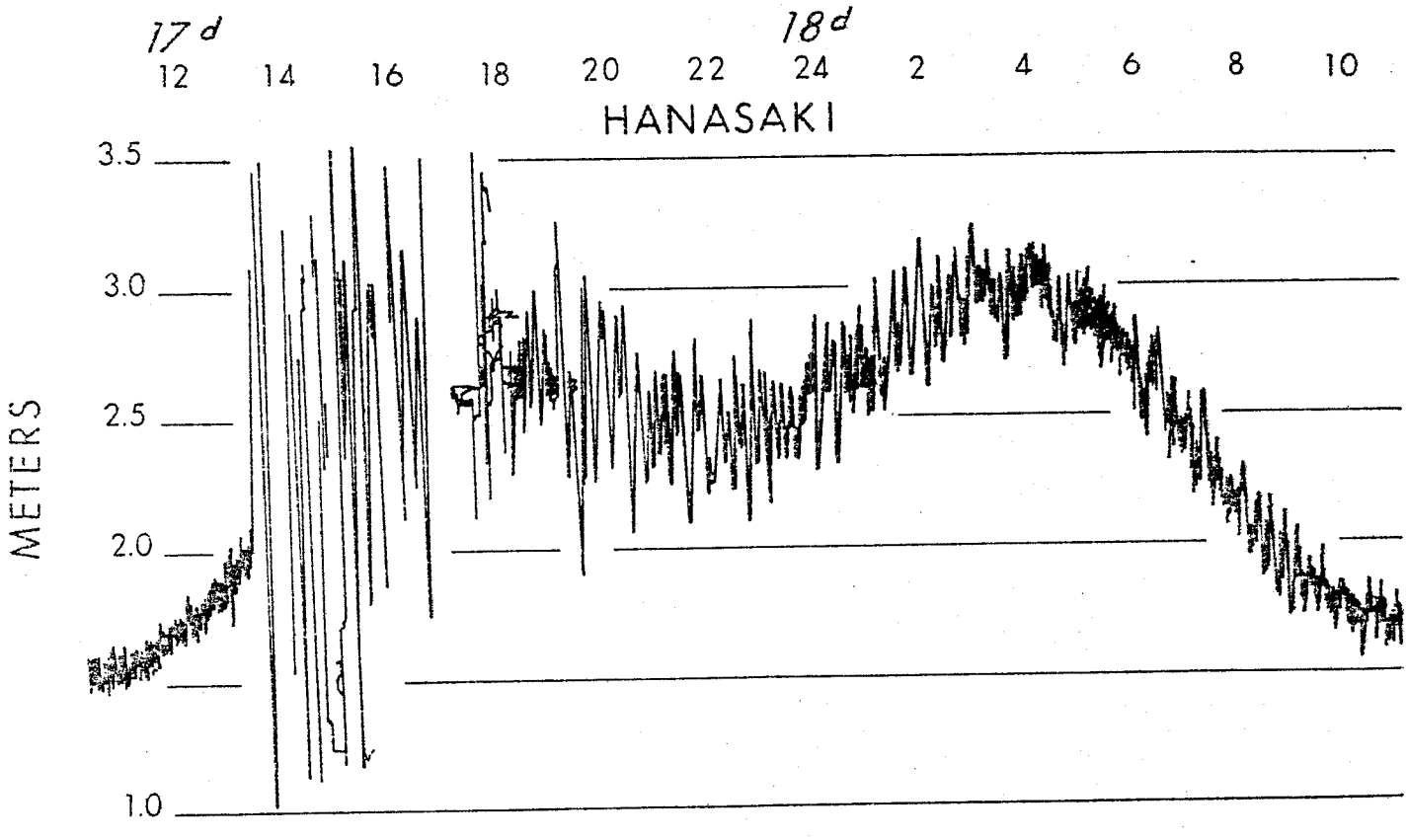
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